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to the velocity of the Earth, in the units here employed. Substituting these values in equation (1), placing

$$D = \sin\sigma \cos i$$
$$D' = \sin\sigma' \cos i'$$

and solving for V, we have

$$V = V_e D \pm \sqrt{V_e^2 D^2 + V'^2 - 2V_e V'D'}$$

D is negative and D′ positive, since $i > 90°$ and $i' < 90°$, the first orbit being retrograde and the second direct; also $\sigma < 180°$. V is necessarily positive, but there is no positive solution of the equation unless

$$V'^2 - 2V_e V'D' > O$$
$$V' > \sqrt{2V_e V'D'}$$

Now V′D′ is the projection of V′ on A′B′ and

$$V'D' \lesseqgtr V_e \text{ according as}$$
$$A'B'C' \lesseqgtr 90°$$

It follows that TISSERAND's criterion is not satisfied by the two orbits, unless

$$V' \lesseqgtr \sqrt{2}V_e$$

But $\sqrt{2}V$ is the parabolic velocity, and, as has already been noted, such an orbit could not have been produced by a previous perturbation.

This test has been applied to orbits of meteors appearing a quarter of a year apart. I venture to suspect, however, that if a computation of the orbits were made possible by accurate observation of the velocities, it would be found that no two orbits belonging to a stationary radiant would satisfy this criterion.

VARIABLE SPOTS ON THE MOON.

By R. S. TOZER.

When the Moon first appears in the western sky after conjunction the visible portion of it does not seem to show any difference in color or shade, but, as it proceeds in its orbit, patches of light and shade begin to develop. At full Moon the contrast between these light and dark patches is at its height, but decreases as the Moon approaches conjunction, disappearing before the crescent is entirely gone.

A portion of the lunar surface which shows these changes on a large scale is that occupied by *Tycho* and his radiating streaks. This is the most prominent feature of the full Moon when it is viewed through a low-power telescope.

It has been supposed that the streaks are enormous cracks filled up from underneath with light-colored lava, and the theory has also been advanced that they are deep ravines filled with snow and ice.

A little study of the streaks will show that there are no ravines associated with them, but that they are color-streaks only, and that they have been laid down literally on top of the hundreds of craters occupying the same territory without destroying them or changing the contour of the surface.

While the basin which forms the center of this feature is best seen when the Sun is rising on that portion of the Moon, the streaks and the dark halo surrounding the crater are not visible until some time afterward and are most distinct at full Moon.

The contrast between the so-called seas and the brighter portions is brought out most strongly at full Moon. There are also numerous smaller variable spots. These begin to darken soon after sunrise, continuing to grow darker until full Moon, and fading gradually as the Moon approaches conjunction. These changes have been attributed to the melting of snow and to the growth of vegetation on the darkening portions, but there is a very simple explanation of the matter which does not require either snow or vegetation.

When light strikes a reflecting surface at a considerable angle of incidence more of it is reflected than when it strikes perpendicularly. At a very large angle of incidence the color or shade of the reflecting surface makes little difference in the amount of light reflected, a dark surface reflecting about the same amount of light as a light one. One of the results of this is to reduce the contrast between different-colored surfaces when obliquely illuminated, while the contrast is heightened by vertical illumination. I quote from GAGE'S Physics: "For example, at perpendicular incidence water reflects about the fiftieth part of the incident light while mercury reflects about two thirds; but at an incidence of 89½° each reflects about 72 per cent of the incident light." That is to say, that with vertical incidence mercury reflects thirty-three times as much as water, making a strong contrast between the two, but at an incidence of 89½° they would appear practically the same.

The principle may be easily proven by experiment. On a piece of white cardboard paste pieces of black paper; place it in a darkened room and project on it at an incidence of 85° or more a pencil of white light, such as the beam of a magic lantern. The light, the screen, and the observer may be so placed that no difference in color can be detected between the white cardboard and the black paper.

When the narrow crescent of the Moon first appears in the western sky at sunset it is almost on a straight line between us and the Sun. The angle of incidence is consequently very great. This angle steadily decreases as the Moon moves on in its orbit, and becomes zero at full Moon, and the differentiation of the light and dark sections increases with the decrease of the angle of incidence.

It would appear at first glance that the crescent Moon should be brighter than the same area of full Moon, while the reverse is said to be the case; but in the case of light striking a very rough surface (like that of the Moon) at a great angle of incidence the elevations will cut off considerable portions of both the incident and reflected light, but they will cut off none in the case of vertical incidence. This reduces the amount of light reflected by the crescent Moon, but it does not have any effect in showing contrast between light and dark areas.

If the Moon were a smooth body it would be brighter at its first appearance after conjunction than the same area of it at opposition.

PATTON, PA., July 27, 1905.